



US 20070113373A1

(19) **United States**(12) **Patent Application Publication****Hato et al.**(10) **Pub. No.: US 2007/0113373 A1**(43) **Pub. Date: May 24, 2007**(54) **VACUUM CLEANER**(52) **U.S. Cl. 15/354**(75) Inventors: **Shigenori Hato**, Kishiwada-shi (JP);
Yasuhiro Oka, Osaka (JP)(57) **ABSTRACT**

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(JP)(21) Appl. No.: **11/589,773**(22) Filed: **Oct. 31, 2006**(30) **Foreign Application Priority Data**

Nov. 21, 2005 (JP) 2005-335513

Nov. 21, 2005 (JP) 2005-336070

Publication Classification(51) **Int. Cl.****A47L 5/28** (2006.01)**A47L 9/02** (2006.01)

A vacuum cleaner in accordance with the present invention is provided with a left cover **40** and a right cover **41**, which cover a suction port body, so as to be movable in the right and left direction to facilitate cleaning by expanding the suction port body when the side of a wall, a corner of a room, and the like are cleaned. When the vacuum cleaner approaches a wall etc., the right cover **41** moves so as to project to the outside from a bumper **3**. A part of the suction port body **2** expands to the side, and an expansion space **A** covered by the right cover **41** is formed on the right-hand side of the suction port body. Dust and dirt on a floor surface facing to this space are sucked through a main suction port **20**. Also, side suction ports **34** made of a flexible material are communicatively formed in both end portions at the right and the left of a dust suction chamber **18** of the suction port body **2** so that dust and dirt is also sucked through the side suction port **34** when the side of wall is cleaned. The side suction port **34** is formed so as to project to the side from the overall width of a cleaner body, so that dust and dirt at the side are easily sucked for cleaning when the vacuum cleaner runs along the side of wall etc.

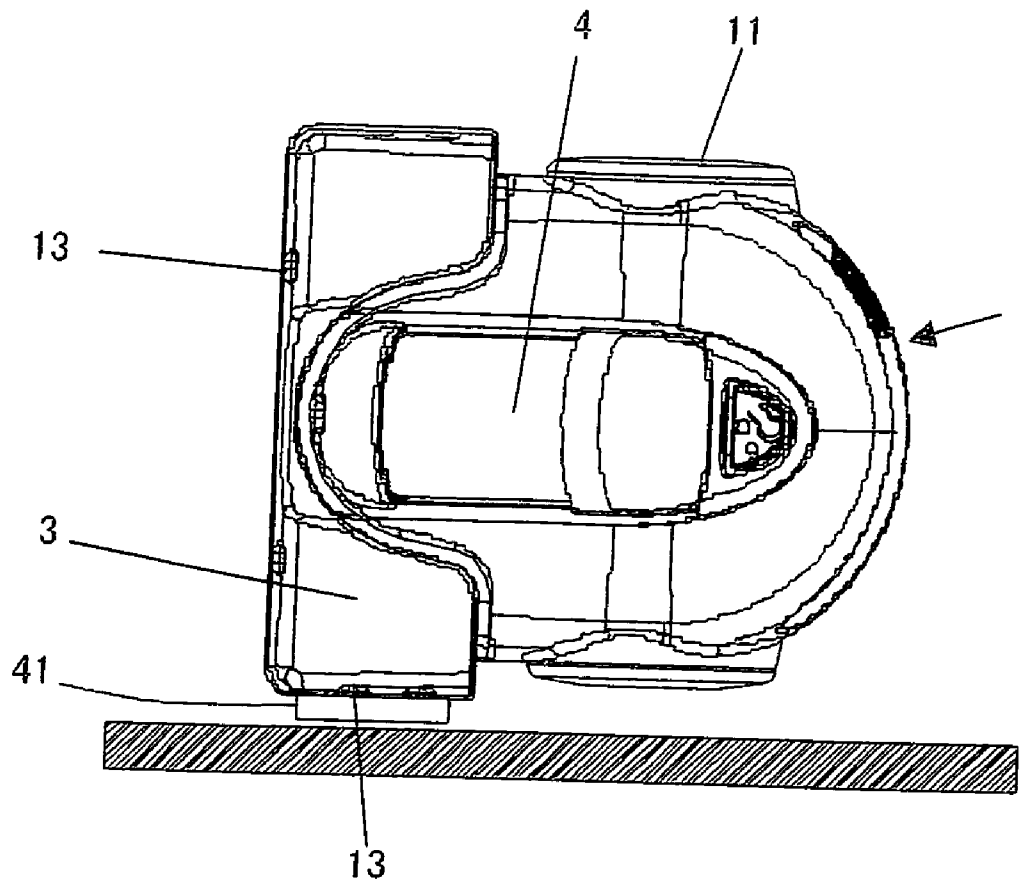


FIG. 1

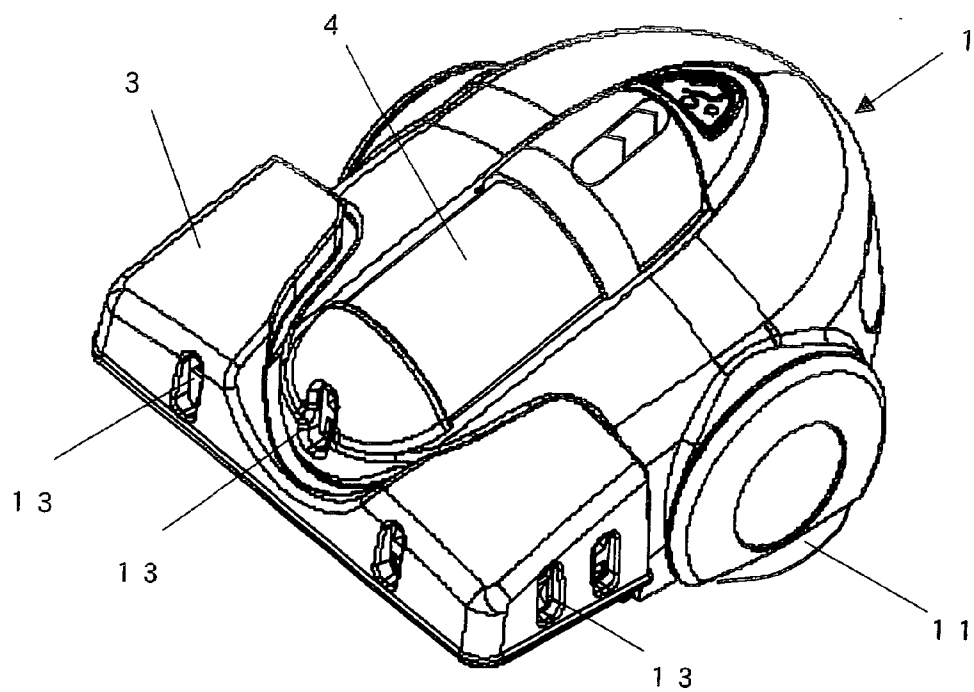


FIG. 2

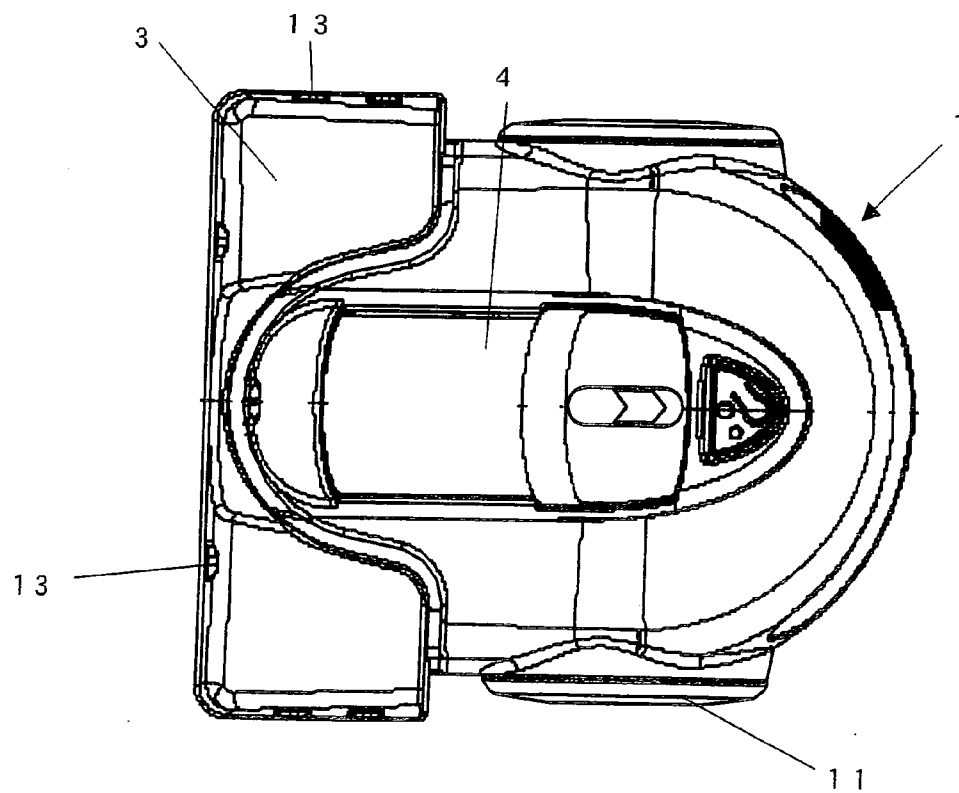


FIG. 3

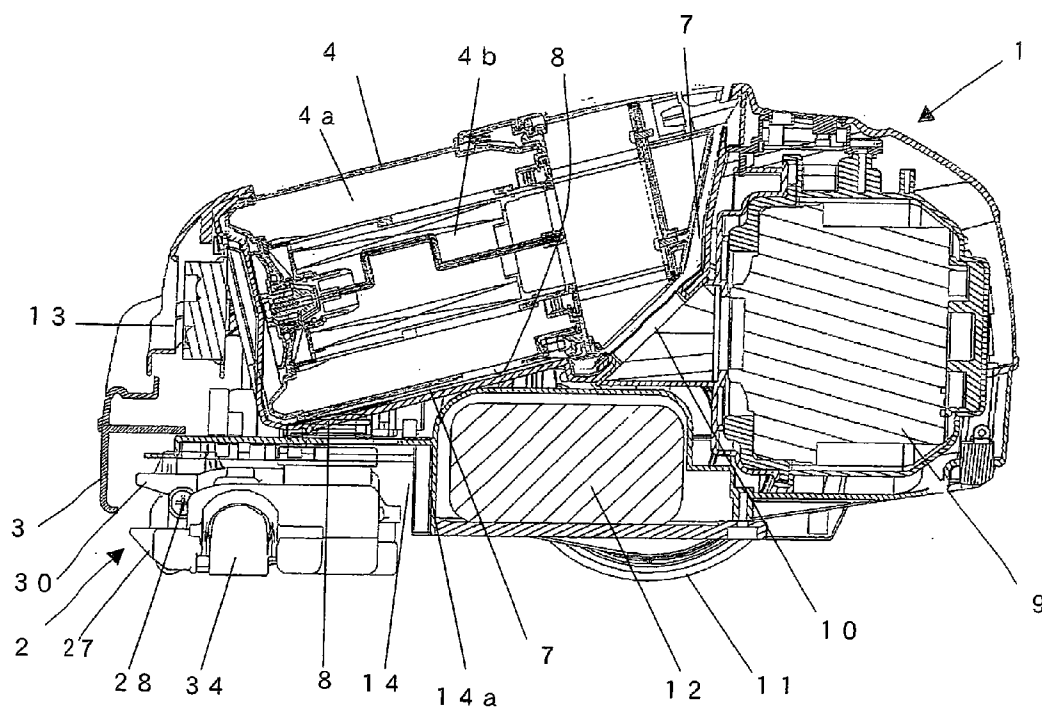


FIG. 5

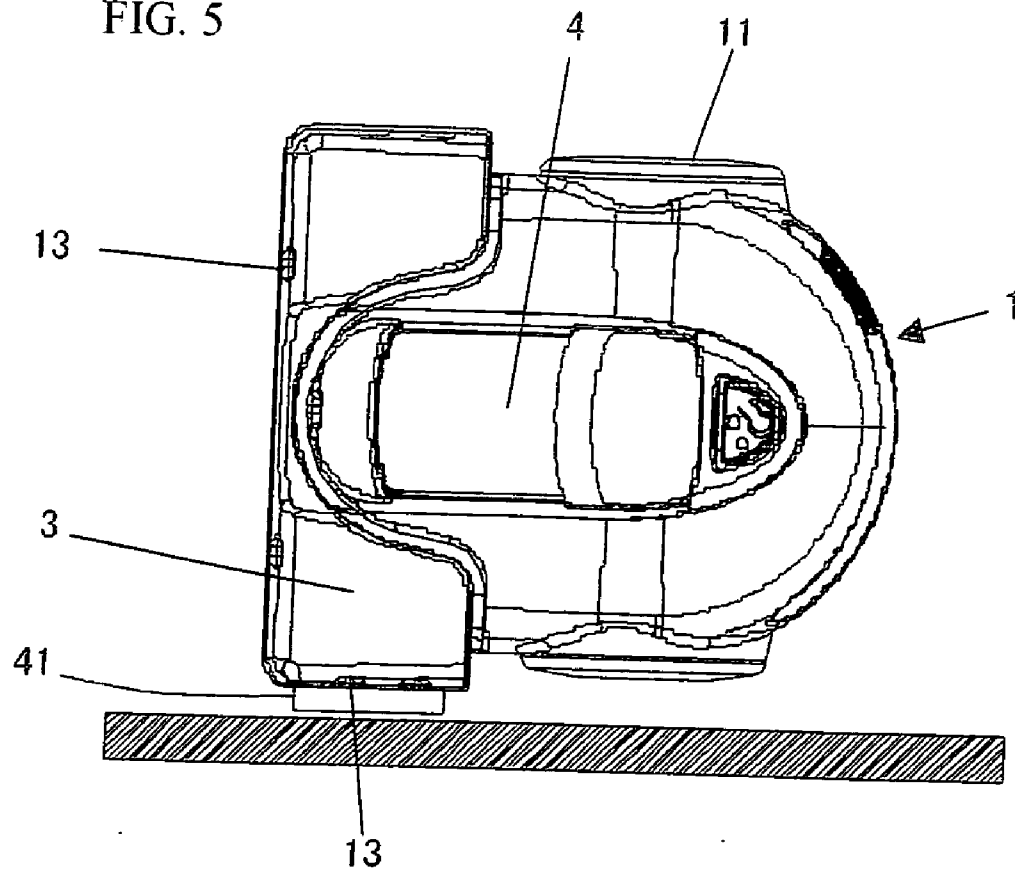


FIG. 6

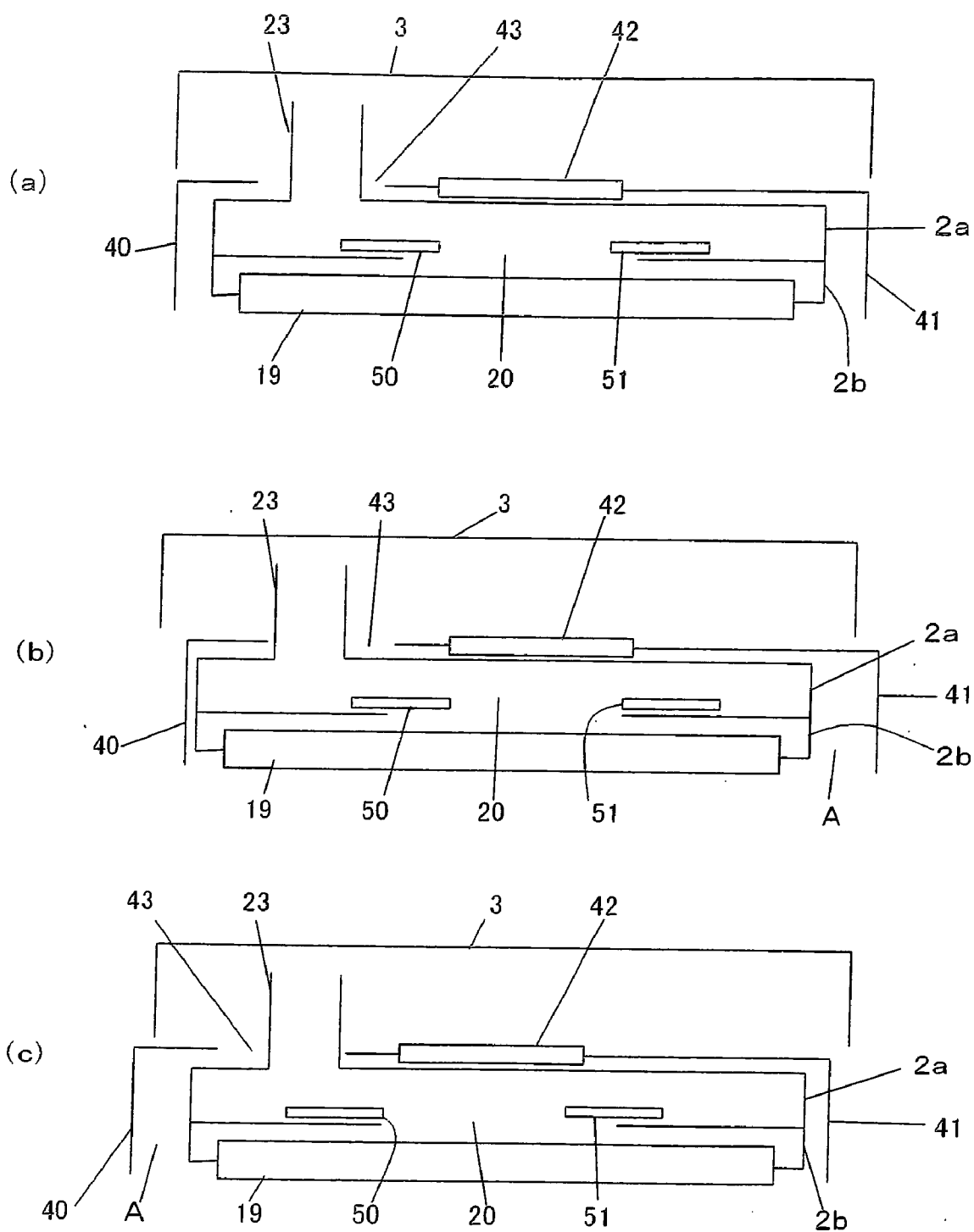


FIG. 7

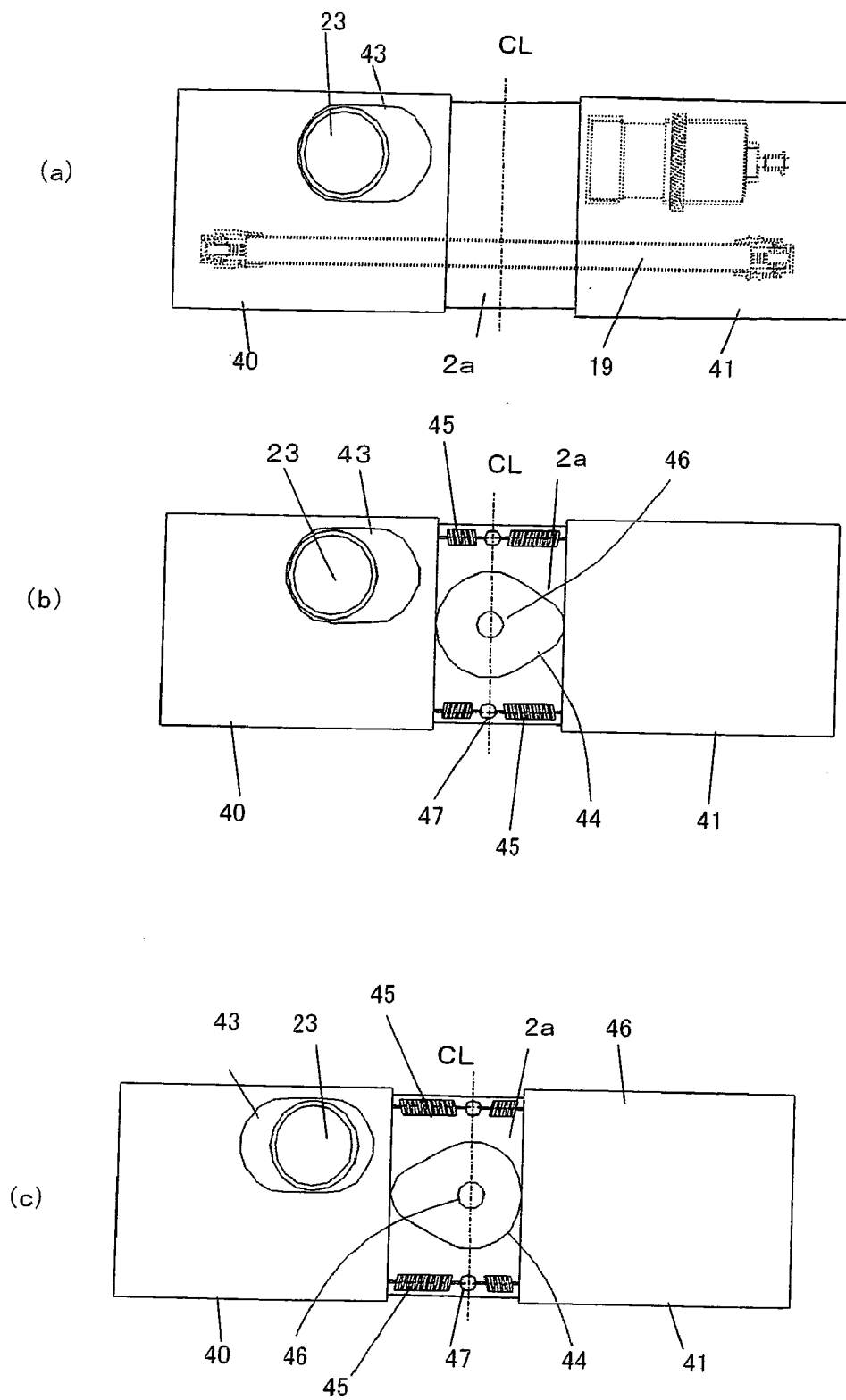


FIG. 8

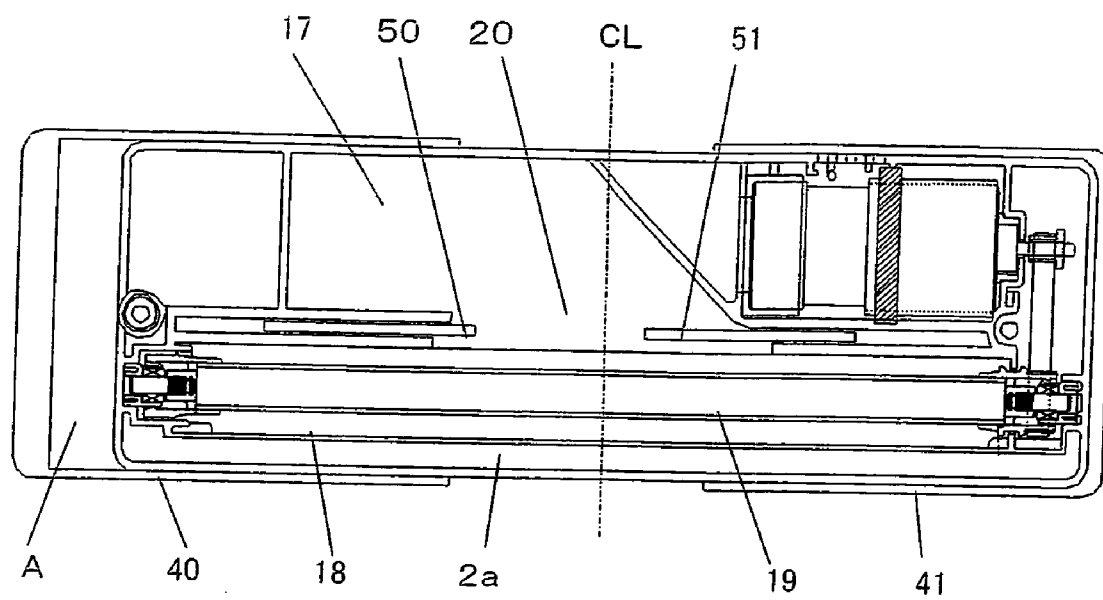


FIG. 9

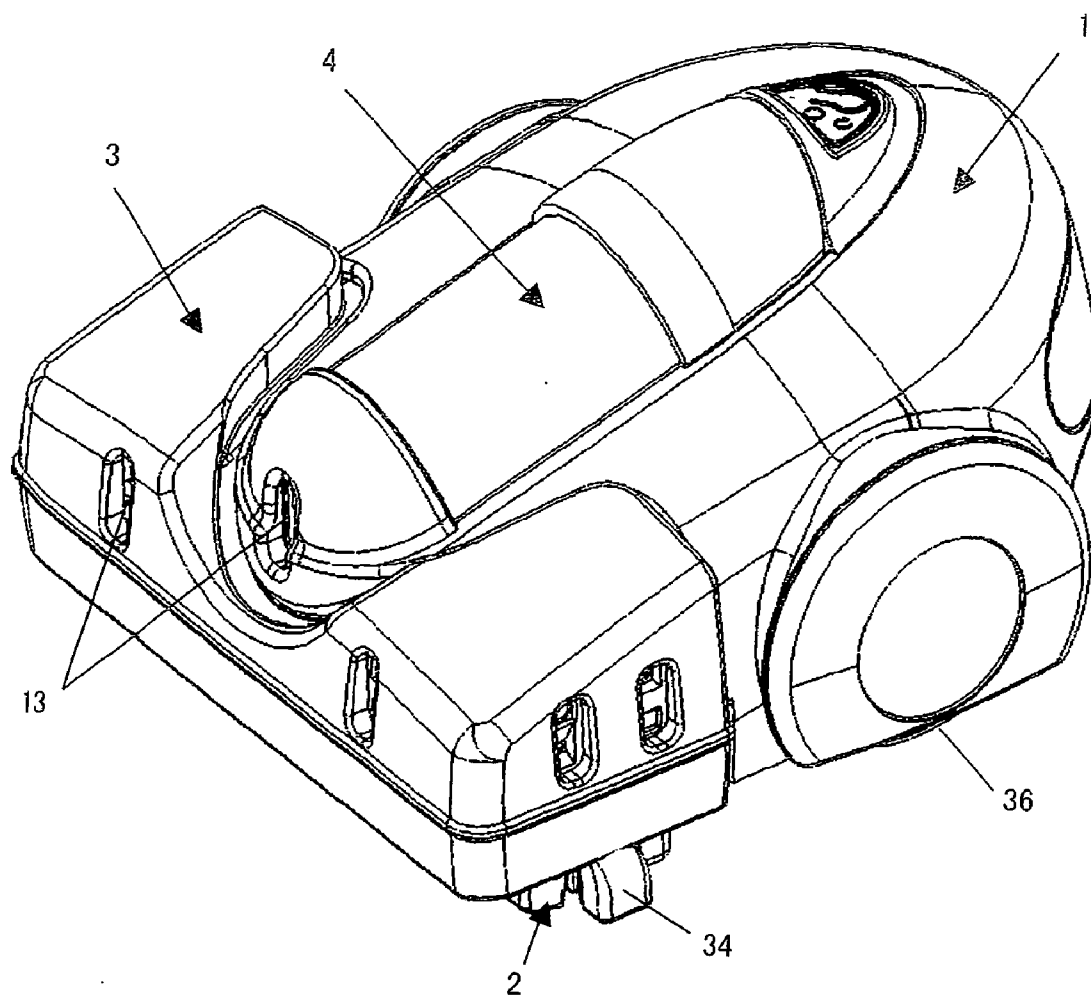


FIG. 10

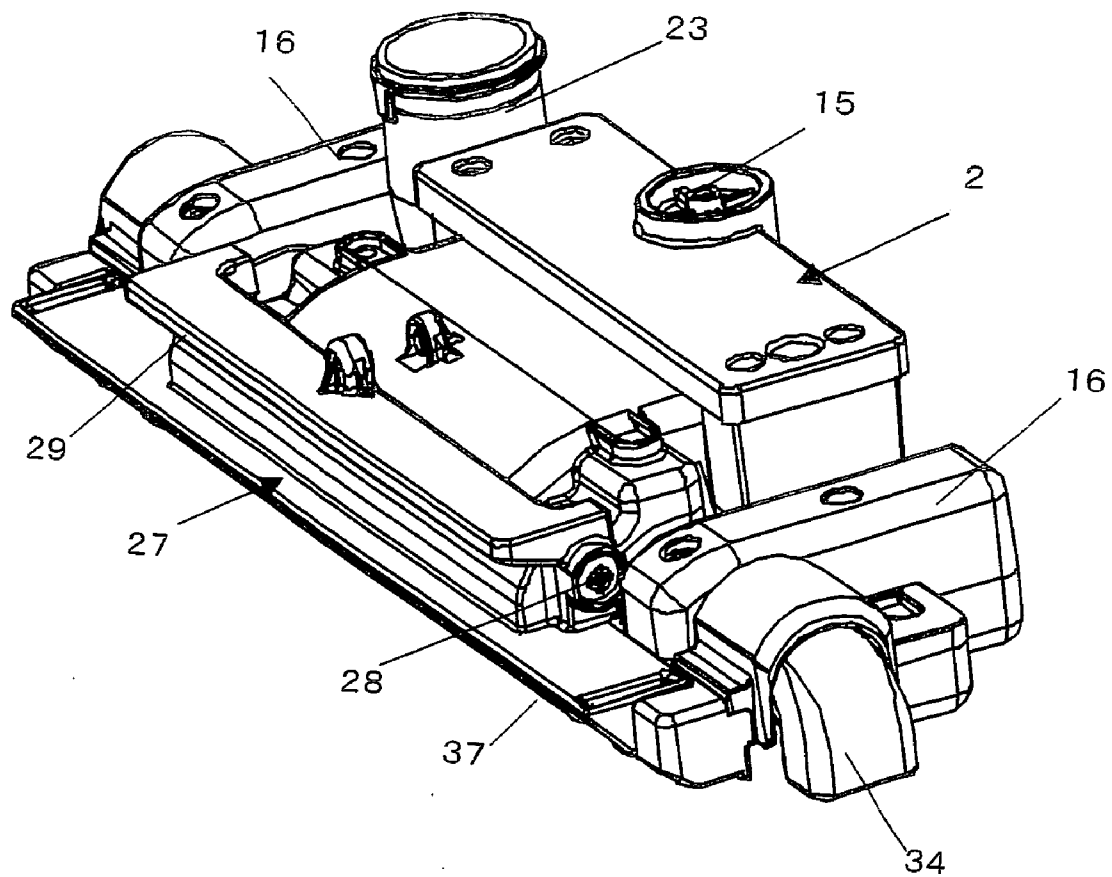
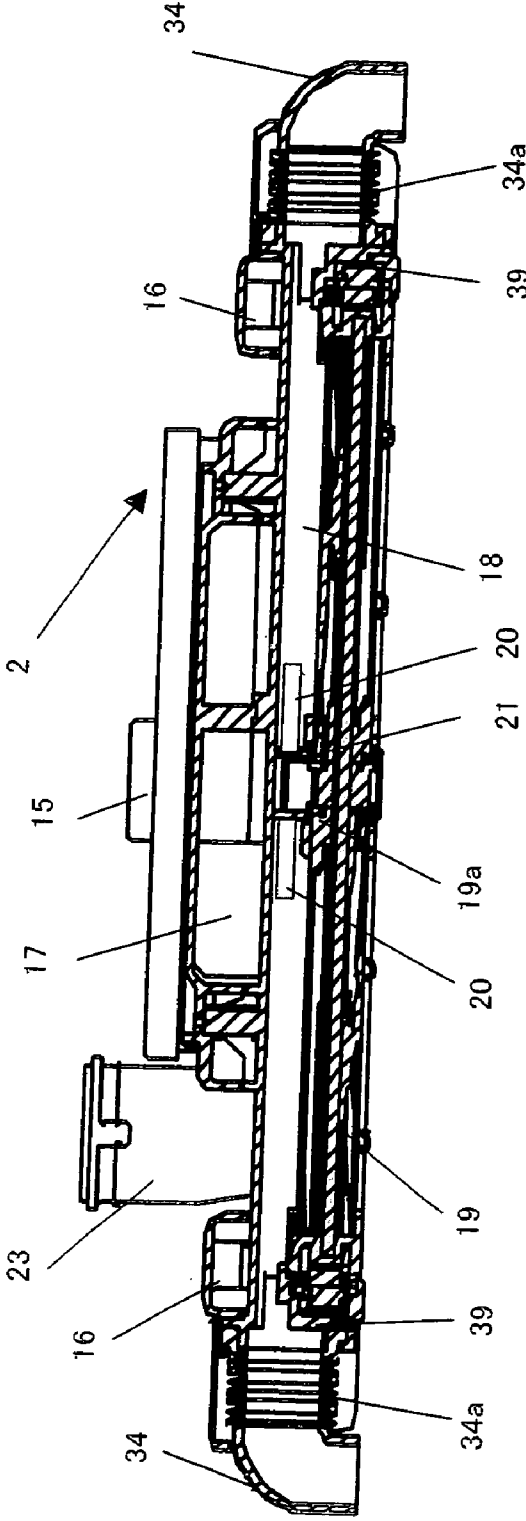


FIG. 11



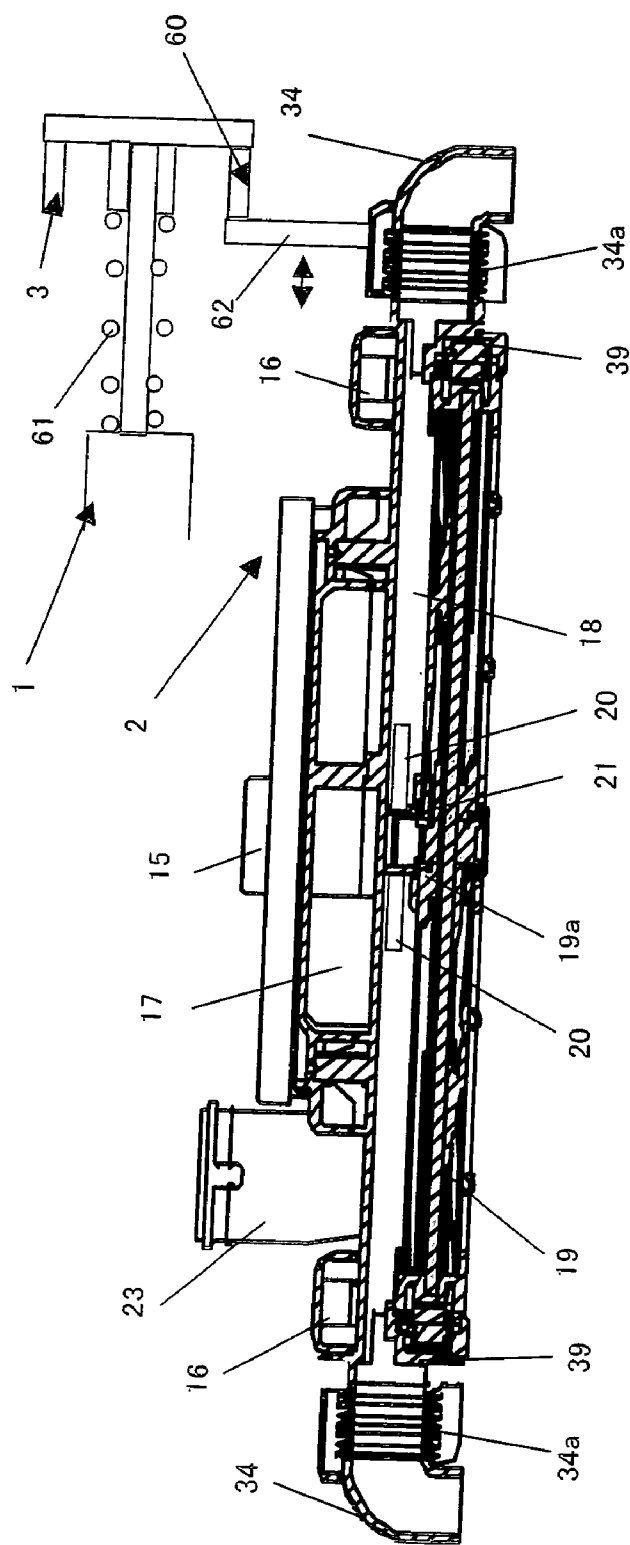


FIG. 12

VACUUM CLEANER

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a vacuum cleaner that performs cleaning while running automatically.

BACKGROUND ART

[0002] As a technique for cleaning the corners of wall surfaces in the conventional vacuum cleaner, Japanese Patent Laid-Open No. 2004-350713 has disclosed a self-propelled vacuum cleaner in which a suction port body is provided so as to be movable in the transverse direction with respect to the advancing direction to clean a corner portion using the suction port body projecting from a cleaner body.

[0003] Also, Japanese Patent Laid-Open No. 2005-6857 has disclosed a vacuum cleaner in which a corner brush that can project and retract from a main suction port toward the direction crossing the running direction of cleaner body is provided, and the corner brush is provided with a corner suction port for sucking dust and dirt on the floor surface. In this vacuum cleaner, the main suction port sucks dust and dirt on the floor surface and the corner suction port sucks dust and dirt on the floor surface at the side of an obstacle, by which the floor surface can be cleaned surely. Also, even if the corner brush comes into contact with the obstacle, the corner brush retracts toward the rear of the cleaner body, so that the obstacle etc. can be prevented from being damaged. Problems to be Solved by the Invention

[0004] However, the self-propelled vacuum cleaner described in Japanese Patent Laid-Open No. 2004-350713 has a disadvantage that since the suction port body is moved in the transverse direction when a corner portion is cleaned, a part of the floor surface under the cleaner body cannot be cleaned at the time of corner cleaning, so that the surface to be cleaned cannot be cleaned surely.

[0005] Also, in the vacuum cleaner described in Japanese Patent Laid-Open No. 2005-6857, the corner brush is provided so as to be capable of projecting and retracting with respect to the cleaner body by being turnably supported on the cleaner body. In the projecting and retracting operation, a driving means such as a motor for reeling is necessary, which presents a disadvantage of high cost. Also, since a suction path from the corner brush is provided separately from a suction path from the main suction port, a space required for the suction path increases, which presents a disadvantage of a large equipment size.

[0006] The present invention has been made in view of the above circumstances, and accordingly an object thereof is to provide a compact vacuum cleaner capable of easily cleaning a portion near a wall or at a corner.

SUMMARY OF THE INVENTION

[0007] To achieve the above-object, in the present invention, a suction port body having a suction port is provided on the front side of a cleaner body, and an expanding means for expanding the suction port body toward the side is provided. Accordingly, the suction port body itself is not moved, and a part of the suction port body is expanded to the side by using the expanding means. By this expansion, the region capable of being cleaned by the suction port body is widened to the side of wall, so that the side of wall can be cleaned.

[0008] The suction port body has a rotating brush, and the suction port communicating with a dust collection section is formed on a wall surface of a dust suction chamber of the suction port body accommodating the rotating brush. Therefore, the expanding means is configured so that a part of the suction port body is projected from the cleaner body to expand the dust suction chamber to the side. That is to say, a case or a cover of the suction port body constituting the dust suction chamber is made expandable and contractible to the side. The case or the cover is a member constituting a part of the suction port body. When the side of wall is cleaned, the dust suction chamber is expanded by extending this member. At the time of ordinary cleaning such that a central portion of a room is cleaned, this member is contracted, and is not projected from the cleaner body. Therefore, this member does not collide with an obstacle, and therefore does not hinder the running of the cleaner body.

[0009] A suction port variable means is provided to displace the suction port in the projecting direction in association with the expansion of the suction port body. The suction port variable means displaces the suction port by widening the suction port or by shifting the position thereof. When apart of the suction port body projects to one direction, the suction port is also displaced in one direction, and the suction port comes close to the expanded region. Thereby, a sufficient suction force can be obtained in the expanded region.

[0010] An obstacle detector is provided to detect an obstacle located at the front and at the side of the cleaner body so that the vacuum cleaner approaching the side of wall or a corner of room can be detected. At the time of this detection, the expanding means projects a part of the suction port body from the cleaner body. Also, when the vacuum cleaner goes away from the side of wall or when cleaning at the side of wall is finished, the expansion means retracts apart of the suction port body into the cleaner body. Therefore, the suction port body does not hinder the running of the cleaner body. The finish of cleaning of the side of wall is judged from a change of running of cleaner body from advance to retreat or from advance to turning.

[0011] Also, as the expanding means, side suction ports extending from the suction port body toward the side are provided, by which the region capable of being cleaned by the suction port body can be expanded to the side of wall. That is to say, in the present invention, a semicylindrical space which is open to the floor surface and the cylinder center axis of which is directed in the right and left direction is formed, and this space is used as the dust suction chamber. In the front wall surface of the dust suction chamber, a main suction port is formed to suck dust and dirt from the floor surface together with air. Also, the side suction ports are communicatively formed in both end portions at the right and the left of the dust suction chamber. When the floor at the side of wall or at a corner of room is cleaned, the side suction port is used. At this time, the side suction ports are also communicatively formed in the right and left end portions of the dust suction chamber. Therefore, a suction system for sucking dust and dirt from the main suction port and a suction system for sucking dust and dirt from the side suction ports join to each other, so that the suction system can be simplified.

[0012] If the side suction port is formed of a flexible material, even if the side suction port collides with the wall,

the wall surface is not damaged. Also, since the side suction port projects to the side from the overall width of the cleaner body, when the vacuum cleaner runs at a corner of room or at the side of wall, dust and dirt at the side can easily be sucked for cleaning. At this time, even in the case where the side suction port collides with the wall, the wall surface is not damaged because the side suction port is formed of a flexible material.

[0013] In the dust suction chamber, the side suction port is communicatively formed at the side, and the rotating brush is supported by bearing portions, so that fine dust and dirt having been sucked through the side suction port may intrude into the bearing portion. Therefore, the bearing portions at both ends of the rotating brush each are covered by a dust-proof cover to prevent the dust and dirt having been sucked through the side suction port from intruding into the bearing portion.

[0014] In the case where a bumper is provided so as to cover the front and the side of the cleaner body, and the bumper is attached to the cleaner body so as to be movable in the front and rear direction and in the right and left direction, the configuration can be made such that the side suction port is provided on the same surface as the side surface of the bumper and is moved in association with the movement in the right and left direction of the bumper. According to this configuration, even if the bumper collides with the wall surface and moves to the inside in the right and left direction, the side suction port follows, and therefore the side suction port is prevented from being left alone and damaging the wall surface.

[0015] As described above, according to the present invention, a part of the suction port body is projected from the cleaner body to expand the region capable of being cleaned, whereby the side of wall, furniture, or the like can be cleaned. Since only a part of the suction port body has to be moved, a moving mechanism can be made simple as compared with the case where the whole of the suction port body is moved. Also, a space necessary for moving the suction port body is not needed, and the size of the cleaner body can be reduced.

[0016] Also, since the side suction ports are communicatively formed in both end portions at the right and the left of the suction port body, dust and dirt at the side of wall or at a corner of room can be sucked for cleaning through the side suction port. At this time, the side suction ports are also communicatively formed in the right and left end portions of the dust suction chamber. Therefore, the suction system for sucking dust and dirt from the main suction port and the suction system for sucking dust and dirt from the side suction ports join to each other, so that the suction system can be simplified.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a perspective view of a self-propelled vacuum cleaner in accordance with a first embodiment of the present invention;

[0018] FIG. 2 is a plan view of the self-propelled vacuum cleaner;

[0019] FIG. 3 is a side sectional view of the self-propelled vacuum cleaner;

[0020] FIG. 4 shows a suction port body, FIG. 4(A) being a side sectional view at the time when an opening/closing body is in an open posture, and FIG. 4(B) being a side sectional view at the time when an opening/closing body is in a closed posture;

[0021] FIG. 5 is a plan view of a vacuum cleaner at the time when a portion near a wall is cleaned;

[0022] FIG. 6 is views schematically showing the construction of an expanding means of a suction port body, FIG. 6(A) showing an ordinary state of the suction port body, FIG. 6(B) showing a state in which the suction port body is expanded in the right direction, and FIG. 6(C) showing a state in which the suction port body is expanded in the left direction;

[0023] FIG. 7 is a plan view of a suction port body, FIG. 7(A) showing an ordinary state of the suction port body, FIG. 7(B) showing a state in which the suction port body is expanded in the right direction, and FIG. 7(C) showing a state in which the suction port body is expanded in the left direction;

[0024] FIG. 8 is a view showing the interior of a suction port body at the time when the suction port body is expanded in the right direction;

[0025] FIG. 9 is a perspective view of a self-propelled vacuum cleaner in accordance with a second embodiment of the present invention;

[0026] FIG. 10 is a perspective view of a suction port body;

[0027] FIG. 11 is a front sectional view of the suction port body shown in FIG. 10; and

[0028] FIG. 12 is a front sectional view of a suction port body, showing a modification of the second embodiment.

PREFERRED EMBODIMENT OF THE INVENTION

First Embodiment

[0029] FIGS. 1 to 8 show a first embodiment of the present invention. An embodiment of a vacuum cleaner in accordance with the present invention will be explained by taking a self-propelled vacuum cleaner, which moves in a self-standing manner in a surrounded space in which obstacles such as room walls, furniture, and beds are present, as an example.

[0030] As shown in FIGS. 1 to 3, this vacuum cleaner includes a cleaner body 1, a suction port body 2 for sucking dust and dirt on the floor surface, a bumper 3 disposed on the front side of the cleaner body 1, a dust collector 4 serving as a dust collecting section mounted detachably on the cleaner body 1, and a steering means for controlling a running means running on the floor surface and the running direction.

[0031] In the cleaner body 1, a semicylindrical accommodation concave portion 7 is formed on the upper surface of an oval casing, and a capsule-form dust collector 4 is mounted detachably in the accommodation concave portion 7. In the accommodation concave portion 7, an introduction port 8 is formed to introduce dust and dirt sucked together with air from the suction port body 2 to the dust collector

side, and also an exhaust port 10 is formed to exhaust the air coming from the dust collector 4 to a motor-driven blower 9 at the rear part of the casing. The dust collector 4 is connected to the introduction port 8 on the upstream side in the air flow direction, and is connected to the exhaust port 10 on the downstream side.

[0032] The dust collector 4 is housed detachably in the accommodation concave portion 7 formed on the upper surface of the cleaner body 1. The dust collector 4 is of a cyclone type. Intake air containing dust and dirt that is sucked from the suction port body 2 into a dust collection chamber 4a swirls in the dust collection chamber 4a. Dust and dirt is separated from air by a filter of an exhaust cylinder 4b. The dust and dirt are accumulated in the dust collection chamber 4a. The air sucked is exhausted to the outside of the dust collection chamber 4a.

[0033] The bumper 3 is attached so as to be moved in the front and rear direction and the right and left direction by a spring (not shown) to ease a shock produced when the front portion of the cleaner body 1 collides with an obstacle, a wall surface, or the like. Thus, the cleaner body 1 including the bumper 3 takes a rectangular front-side shape. The suction port body 2 is disposed on the front side of the cleaner body 1. The cleaner body 1 can approach the side of a wall, the side of furniture, and the corner of room to facilitate the cleaning of these places.

[0034] Also, under the accommodation concave portion 7, there is provided a control section 12 provided with a control circuit board etc. for controlling driving wheels 11 for running the cleaner body 1 and the motor-driven blower 9. On the front surface and the side surface of the bumper 3, obstacle detecting sensors 13 are provided to detect an obstacle in the surroundings. Also, on the front side of the dust collector 4 as well, an obstacle detecting sensor 13 is disposed. The obstacle detecting sensor 13 is a reflective type optical sensor or an ultrasonic sensor, and detects the presence of an obstacle in a noncontact manner.

[0035] A running means for running the cleaner body 1 consists of the driving wheels 11 and motors for turning the driving wheels. The right and left driving wheels 11 turn independently. The motor for each of the driving wheels 11 is controlled by the control section 12. Therefore, the driving wheels 11 and the control section 12 constitute the steering means for controlling the running direction. The control section 12 controls the driving of the motors while detecting an obstacle at the front and at the side based on a detection signal sent from the obstacle detecting sensor 13. Therefore, the cleaner body 1 can run straight and turn while keeping away from obstacles. Also, the cleaner body 1 can move along the side of wall.

[0036] Next, the suction port body 2 is explained. As shown in FIGS. 3 and 4, the suction port body 2, which has a cleaning means for cleaning the floor surface, is disposed in a concave portion 14 formed on the front bottom surface of the cleaner body 1, and the rear end portion thereof is supported on the cleaner body 1 so as to be swayable around a vertical shaft 15 (refer to FIG. 10). Also, in the rear end portion of the suction port body 2, shock absorbers 16 (refer to FIG. 10) are provided on both sides, right and left, with the vertical shaft 15 being held there between to ease a shock when the suction port body 2 comes into contact with a rear surface 14a of the concave portion 14. Thereby, the suction

port body 2 can sway around the vertical shaft 15 with respect to the cleaner body 1 in the sway range of about 30 degrees. Therefore, the cleaner body 1 can run straight while keeping its balance in the right and left direction.

[0037] As shown in FIG. 4, the suction port body 2 is formed with a suction flow path 17 enclosed by a lower case 2b and an upper case 2a. The front bottom surface of the lower case 2b is concaved, and a space having a semicircular cross section is used as a dust suction chamber 18. In the dust suction chamber 18, a rotating brush 19, which serves as the cleaning means, is housed so as to be rotatable around a horizontal shaft 19a. In the front wall surface of the dust suction chamber 18, a main suction port 20 is formed to suck dust and dirt from the floor surface together with air. The main suction port 20 is located in the center in the right and left direction of the front wall surface.

[0038] The rotating brush 19, in which bristles are arranged in a spiral form on the circumferential surface, is driven by a motor and a belt (neither is shown) provided on the suction port body 2. The motor may be disposed on the cleaner body side near the vertical shaft 15, which is the turning center of the suction port body 2, to drive the rotating brush 19 by transmitting the power on the cleaner body side with a belt. The driving of the rotating brush 19 is controlled so that the direction of rotation thereof is reverse to the advancing direction of the driving wheels 11. Therefore, the rotating brush 19 strikes the floor surface to cause dust and dirt to float, and the floating dust and dirt are guided to the center side in the right and left direction.

[0039] Also, a partitioning wall is formed at the central position in the right and left direction of the dust suction chamber 18, and the main suction port 20 is formed near the partitioning wall. The dust and dirt conveyed to the center side by the rotating brush 19 is sucked into the suction flow path 17 through the main suction port 20.

[0040] The main suction port 20 is formed in the tangential direction on the front upper side of the dust suction chamber 18, and communicates with the suction flow path 17. In the dust suction chamber 18, therefore, a swirl flow is generated by the rotation of the rotating brush 19 so that the dust sucking capability is enhanced along with the suction flow in the tangential direction acting on the main suction port 20 due to the driving of the motor-driven blower 9.

[0041] Further, on the front side of the main suction port 20, a front suction port 22 is formed which is open in the floor surface and communicates with the suction flowpath 17 so that the dust and dirt at the side of a front wall can be sucked. The downstream side of the suction flow path 17 communicates with the introduction port 8 in the accommodation concave portion 7 through a flexible elbow tube 23. The elbow tube 23 is located on one side in the right and left direction.

[0042] The dust and dirt having been sucked through the main suction port 20 and the front suction port 22 are introduced together with air from the elbow tube 23 into the dust collector 4 through the introduction port 8 after passing through the suction flow path 17. The dust and dirt having flown into the dust collector 4 are separated from the air by the swirl flow in the dust collection chamber 4a, and the dust and dirt are collected in the dust collection chamber 4a. The air is exhausted to the outside of the chamber by the

motor-driven blower 9 after passing through the exhaust cylinder 4b and the exhaust port 10.

[0043] The front suction port 22 is open in almost the overall width in the right and left direction at the front end of the suction port body 2, and an opening/closing body 27 for opening and closing the front suction port 22 is provided. As shown in FIG. 4, the opening/closing body 27 is formed by a plate-shaped member supported on the suction port body 2 so as to be turnably opened/closed around a horizontal shaft 28. At the lower end of the opening/closing body 27, an auxiliary wheel 29 is provided so as to be turnable around a horizontal shaft. The auxiliary wheel 29 rotates in contact with the floor surface and closes the front suction port 22 when the opening/closing body 27 is in a closing posture, and leaves from the floor surface and opens the front suction port 22 when the opening/closing body 27 is in an opening posture. The opening/closing body 27 with the auxiliary wheel 29 makes it possible for the cleaner body 1 to run while going up onto a height difference of floor surface smoothly. Moreover, the auxiliary wheel 29 is utilized as a closing means of the front suction port 22, so that the number of parts can be reduced.

[0044] Also, on the front surface of the opening/closing body 27, a protrusion 30 that comes into contact with the bumper 3 when the bumper 3 retracts is formed in the right and left direction. If the protrusion 30 comes into contact with the bumper 3, the opening/closing body 27 turns around the horizontal shaft 28 to open the front suction port 22. Also, the front end surface of the opening/closing body 27 is formed with an inclined surface 31 inclined downward from the front end toward the rear end so that the cleaner body 1 can easily get over a height difference of floor surface.

[0045] The suction port body 2 is configured so as to be capable of expanding in the right and left direction. Specifically, as shown in FIG. 5, a part of the suction port body 2 projects from the cleaner body 1 to either one side in the right and left direction. Thereby, the suction port body 2 is expanded to the side from the cleaner body 1, so that the suction port body 2 can be brought close to the side of wall or furniture.

[0046] As an expanding means for expanding the suction port body 2 toward the side, as shown in FIG. 6, covers 40 and 41 covering the suction port main body, which consists of the upper case 2a and the lower case 2b of the suction port body 2, are provided so as to be movable in the right and left direction, and a moving section 42 for moving the covers 40 and 41 is provided. It is to be noted that the right and left are directions at the time when the cleaner body 1 is viewed from the front side.

[0047] As shown in FIG. 7, the covers 40 and 41 are separated from each other to form the left cover 40 and the right cover 41. The covers 40 and 41 are supported on the suction port main body so as to be slidable in the right and left direction, and constitutes a part of the suction port body 2. The covers 40 and 41 cover a portion ranging from the upper surface of the upper case 2a to the front surface, the side surface, and the rear surface of the lower case 2b. Between the covers 40 and 41 and the side surface of the suction port body 2, a clearance is provided to allow the covers 40 and 41 to move. The lower ends of the covers 40 and 41 are located at a position higher than the floor surface.

Also, the upper surfaces of the covers 40 and 41 are located at a position lower than the lower end of the bumper 3 so that the covers 40 and 41 can move in a clearance between the bumper 3 and the floor surface. The left cover 40 is formed with an elongated hole 43 for inserting the elbow tube 23 therethrough. The left cover 40 can be moved in the right and left direction without being hindered by the elbow tube 23.

[0048] The moving section 42 consists of a cam 44, a motor (not shown), and a spring 45. The egg-shaped cam 44 is disposed between the left cover 40 and the right cover 41, and is always in contact with the covers 40 and 41. A rotating shaft 46 of the cam 44 is rotatably supported on the upper case 2a, and is rotated by the motor. When the cam 44 is rotated, the covers 40 and 41 move in the same direction in association with each other according to the shape of the cam 44. The motor is controlled by the control section 12. When the cleaner body 1 approaches the side of wall or furniture, the control section 12 moves the covers 40 and 41 in the direction such that the covers 40 and 41 are brought close to the side of wall etc.

[0049] Between the covers 40 and 41, a pair of right and left springs 45 are provided. One end of each of the springs 45 is attached to the cover 40 or 41, and the other end thereof is attached to a pillar 47 erected on the upper case 2a. The covers 40 and 41 are urged by the springs 45 so as to come to the center. The rotating shaft 46 and the pillars 47 are located on the centerline CL perpendicular to the right and left direction. This center line CL is in variable with respect to the cleaner body 1 and the suction port body 2.

[0050] Also, a suction port variable means is provided to displace the main suction port 20 in the right and left direction in association with the expansion of the suction port body 2. As shown in FIGS. 6 and 8, a pair of right and left shutters 50 and 51 are provided in the main suction port 20 of the suction port body 2. Each of the shutters 50 and 51 is movably supported on the inside of the lower case 2b, and is moved in the same direction by a motor or a solenoid. These elements constitute the suction port variable means. The clearance between the shutters 50 and 51 is set so as to be always constant. Even if the shutters 50 and 51 move, the opening area of the main suction port 20 is unchanged; however, the position of the main suction port 20 shifts to the right or the left.

[0051] The driving of the shutters 50 and 51 is controlled by the control section 12 so that the shutters 50 and 51 move in the same direction in association with the covers 40 and 41. The covers 40 and 41 and the shutters 50 and 51 move in either of the right direction and the left direction with the centerline CL being the reference.

[0052] In the case where the side of wall or the side of furniture is cleaned using the above-described vacuum cleaner, when the cleaner body 1 runs, for example, along the side of wall etc. on the right hand side and approaches the wall etc., the wall etc. are detected by the obstacle detecting sensor 13 at the side. Then, the control section 12 moves the covers 40 and 41 and the shutters 50 and 51 in the right direction. As shown in FIGS. 6(B) and 7(B), the cam 44 rotates, and the right cover 41 is moved in the right direction by being pushed by the cam 44. The left cover 40 is moved in the right direction by being pulled by the springs 45. At the same time, the shutters 50 and 51 move in the right direction.

[0053] The right cover 41 is located on the outside of the bumper 3, and projects from the cleaner body 1. In other words, a part of the suction port main body expands to the side. If the right cover 41 shifts in the right direction with respect to the suction port body 2 in this manner, the right cover 41 is located closer to the wall etc. than the cleaner body 1. An expansion space A covered by the right cover 41 is formed on the right-hand side of the suction port main body, and therefore the region capable of being cleaned is expanded to the side. Dust and dirt on the floor surface facing to this expansion space A is sucked from the main suction port 20 together with air. Since the main suction port 20 is displaced in the right direction and approaches the expansion space A, even if a part of the suction port body 2 is expanded, a sufficient suction force can be obtained. Therefore, the side of wall etc. can be cleaned automatically without bringing the cleaner body 1 close to the side of wall etc.

[0054] Inversely, when the cleaner body 1 approaches the side of wall etc. on the left-hand side, as shown in FIGS. 6(C) and 7(C), the left cover 40 is moved in the left direction by being pushed by the cam 44 in the same way. The right cover 41 is moved in the left direction by being pulled by the springs 45. At the same time, the shutters 50 and 51 move in the left direction. An expansion space A covered by the left cover 40 is formed on the left-hand side of the suction port main body, and the main suction port 20 is also displaced in the left direction. Thereby, dust and dirt on the floor surface facing to this expansion space A is sucked, so that the side of wall etc. can be cleaned.

[0055] If a part of the suction port body 2 is expanded in either of the right direction and the left direction, the region capable of being cleaned while the cleaner body 1 advances can be shifted in the right or left direction, so that the side of wall etc. can be cleaned easily.

[0056] When the cleaner body 1 approaches the side of wall etc., the wall etc. are detected by the obstacle detecting sensor 13. The distance from the cleaner body 1 to the wall at the time of detection is set so as to be larger than the length of projection of the cover 40, 41 from the bumper 3, so that the cover 40, 41 can be prevented from colliding with the wall at the time of projection. Also, if the obstacle detecting sensor 13 is used as a distance measuring sensor, the distance to the wall can be found. Therefore, the control section 12 controls the rotation of the cam 44 according to the distance to the wall, thus controlling the moving distances of the covers 40 and 41 and the shutters 50 and 51. When the cleaner body 1 approaches the wall, the moving distances of the covers 40 and 41 are decreased. By doing this, too, the covers 40 and 41 can be prevented from colliding with the wall.

[0057] When the vacuum cleaner advances, the front suction port 22 is closed by the opening/closing body 27. At this time, the dust and dirt struck by the rotating brush 19 float, being sucked through the main suction port 20 together with air, and are introduced into the dust collector 4. The dust and dirt are collected in the dust collection chamber 4a.

[0058] When the bumper 3 collides with a wall etc., the bumper 3 retracts and comes into contact with the protrusion 30 of the opening/closing body 27, by which the opening/closing body 27 is turned upward around the horizontal shaft

28. Then, the auxiliary wheel 29 that has closed the front suction port 22 is turned upward to open the front suction port 22.

[0059] If the blower 9 and the rotating brush 19 are driven in this state, the dust and dirt are introduced to the central portion by a swirl flow generated by the rotating brush 19, and are sucked through the main suction port 20. The dust and dirt at the side of wall are also sucked through the front suction port 22.

[0060] When the vacuum cleaner goes away from the side of wall, the external force is removed from the bumper 3. Therefore, the bumper 3 is restored to the original front position by a spring, not shown, and accordingly, the opening/closing body 27 is also turned in the closed direction by the gravity or a spring, not shown. The auxiliary wheel 29 closes the front suction port 22.

[0061] Since dust and dirt can be sucked together with air through the front suction port 22 located at the front of the main suction port 20, even in the case where the cleaner body 1 collides with a wall etc. and cannot advance further, the dust and dirt at the side of wall can be sucked easily through the front suction port 22, so that the cleaning efficiency can be enhanced. Also, since the front suction port 22 is provided with the opening/closing body 27, when the central portion of the room is cleaned, the front suction port 22 is closed, by which the suction capability of the main suction port 20 can be enhanced.

[0062] When the vacuum cleaner approaches a wall or furniture while advancing along the side of wall etc., the obstacle detecting sensor 13 on the front surface detects the wall etc. During this advance, either one of the covers 40 and 41 is in a projecting state. The cleaning body 1 has a possibility of turning when approaching the wall etc. at the front. Therefore, the control section 12 carries out control so that when the obstacle detecting sensors 13 on the front surface and the side surface detect a wall etc., the projecting cover 40, 41 is retracted. The shutters 50 and 51 return to the original positions in association with the retraction of the cover 40, 41. Therefore, when the cleaner body 1 turns, the covers 40 and 41 are in a state of being housed in the cleaner body 1, and hence do not hinder the turning motion.

[0063] Also, when the vacuum cleaner advances along the side of wall and approaches a wall etc. at the front, the cleaning of the side of wall etc. finishes. When the vacuum cleaner retreats without turning, if the front obstacle detecting sensor 13 detects that the cleaner body 1 is moving away from the front wall, the control section 12 carries out control so that the cover 40, 41 and the shutter 50, 51 are returned to the original position even if the side obstacle detecting sensor 13 detects a side wall etc. Therefore, when the cleaner body 1 retreats, the cover 40, 41 does not project, and hence does not hinder the travel of the cleaner body 1.

[0064] By projecting and retracting a part of the suction port body 2 from the cleaner body 1 as described above, the mechanism of the moving section 42 can be simplified, and also a large space is not needed. Thereby, the construction can be made such that the rectangular suction port body 2 is provided on the front side of the cleaner body 1 formed into a square shape. Usually, the suction port body 2 lies in the cleaner body 1 and does not project to the outside, and hence does not become a hindrance when the cleaner body 1 runs.

[0065] As shown in FIGS. 3 and 4, the configuration may be such that side suction ports 34 are provided on both sides, right and left, of the suction port main body, and each of the side suction ports 34 is formed by an L-shaped nozzle made of rubber etc. to suck dust and dirt at the side. Even if the side suction ports 34 are provided, the cover can be provided so as to cover the side suction port 34.

[0066] Also, the rotating brush may be made movable in the right and left direction by a motor or a solenoid, or may be made capable of being expanded or contracted in the right and left direction. Also, the suction capability at the side of wall etc. can be enhanced by moving or expanding the rotating brush in either direction of right and left in association with the cover and the shutter.

[0067] Also, the covers may be moved independently instead of being moved in association with each other. A driving section such as a motor is provided for each of the covers so that only the cover on the wall side is projected when the cleaner body approaches the side of wall etc. Also, the cover is not divided into two, and one cover for covering the whole of the suction port body may be provided. One cover is moved in the right and left direction. Alternatively, the lower case that forms the dust collection chamber may be made capable of being expanded or contracted, and a cover movable in the right and left direction is attached to the lower case. This cover is projected to the outside of the bumper to expand the dust collection chamber.

[0068] As the driving section of the cover, a link mechanism or a rack-and-pinion mechanism may be used in place of the cam. In this case, the moving distance of the cover is controlled according to the distance to the wall etc. to prevent the cover from colliding with the wall etc.

Second Embodiment

[0069] FIGS. 9 to 11 show a second embodiment of the present invention. In this embodiment, as the expanding means, the side suction ports 34 extending from the suction port main body toward the side are provided to expand the region capable of being cleaned by the suction port 34 to the side of wall.

[0070] The suction port body 2 is provided with the side suction ports 34 on both sides, right and left, of the dust suction chamber 18. Each of the side suction ports 34 is made of a flexible material such as rubber, and is formed by an L-shaped tubular nozzle whose lower surface is open. A proximal end portion 34a of the side suction port 34 is formed into a bellows shape so as to be deformed and absorb a shock even when the cleaner body 1 collides with a wall surface at the time of cleaning. The side suction ports 34 are communicatively connected to both end portions at the right and left of the dust suction chamber 18, and a suction path through which dust and dirt flow into the suction flow path 17 after passing through the main suction port 20 in the center of the dust suction chamber 18 is formed.

[0071] The both end portions at the right and left of the dust suction chamber 18 are bearing portions of the rotating brush 19. The bearing portion is covered by a dust-proof cover 39 to prevent the dust and dirt having been sucked through the side suction port 34 from intruding into the bearing portion. The dust-proof cover 39, which is also used as a bearing, has a tubular construction whose outer end side

is closed, and the shaft 19a of the rotating brush 19 is supported in the dust-proof cover 39 so as to be fitted therein.

[0072] Communicating portions at both ends, right and left, of the side suction port 34 and the dust suction chamber 18 are provided so that the opening area is smaller than that of other portions and hence so that the flow rate is high because the bearing portion of the rotating brush 19 is present. Therefore, the dust and dirt having been sucked through the side suction port 34 pass through the dust suction chamber 18 and are sucked to a suction path 25 through the main suction port 20 efficiently.

[0073] Also, the side suction port 34 is projected to the side from the side surface of the cleaner body 1, and is projected to the side to the same degree as the transverse width of the bumper 3 or slightly to easily remove dust and dirt at the side of wall etc. Since the side suction port 34 is formed of a flexible material such as rubber, even if the side suction port 34 is projected to the side from the bumper 3, the vacuum cleaner can run while the side suction port 34 is deflected.

[0074] Thus, the suction path 25 for separating and collecting the dust and dirt having been sucked through the main suction port 20 together with air follows the above-described path. Also, for the suction flow path 17 of the suction port body 2, the front suction port 22 forms a path 17c having an arcuate shape, in the side view, toward the rear, and a rear flow path 17d is formed so as to be open to the main suction port 20 in an intermediate portion and widen in the right and left direction on the rear end side. The flexible elbow tube 23 is connected to the end portion of the rear flow path 17d. The elbow tube 23 forming a part of the suction path 17 is formed of a flexible rubber elastic material, and apart thereof is formed into a bellows shape, so that even when the suction port body 2 turns around the vertical shaft 15, the path of the suction path 17 can be secured.

[0075] The running means for running the cleaner body 1 includes the driving wheels 11 and the auxiliary wheel 29. The driving wheels 11 rotate independently, and are configured so as to make straight running and turning possible by controlling each of the driving wheels 11. Therefore, the driving wheels 11 and the control section 12 for controlling the driving wheels 11 constitute the steering means for controlling the running direction.

[0076] According to the above-described configuration, when the vacuum cleaner runs along the side of wall, dust and dirt at the side of wall can be sucked for cleaning by the side suction port 34. At this time, since the side suction ports 34 are communicatively formed in the right and left end portions of the dust suction chamber 18, a suction system for sucking dust and dirt from the main suction port 20 and a suction system for sucking dust and dirt from the side suction ports 34 join to each other. Since the suction system is simplified, a suction system that is compact as a whole can be formed.

[0077] Also, the side suction port 34 can be projected to the side from the overall width of the cleaner body 1. If the side suction port 34 is projected to the side from the cleaner body 1, dust and dirt at the side of wall can easily be sucked for cleaning when the vacuum cleaner runs along the side of wall. At this time, in the case where the side suction port 34

collides with a wall, the wall surface is not damaged because the side suction port **34** is made of a flexible material.

[0078] The dust and dirt having been sucked through the side suction port **34** are sucked to the dust suction chamber **18** side. At this time, since the rotating brush **19** is provided with the dust-proof cover **39**, even if fine dust and dirt are going to intrude into the bearing portion of the rotating brush **19** through the side suction port **34**, the intrusion of fine dust and dirt can be prevented by the dust-proof cover **39**.

[0079] FIG. 12 shows a modification of the second embodiment. In this modification, the side suction port **34** is disposed on the same surface as the side surface of the bumper **3**, and is connected by an interlock mechanism **60** so as to move in association with the movement in the right and left direction of the bumper **3**.

[0080] The bumper **3** is attached to the cleaner body **1** so as to be movable in the front and rear direction and the right and left direction, and is urged to the outside by a spring **61**. The interlock mechanism **60** has a connecting body **62** for connecting the bumper **3** to the side suction port **34**. The side suction port **34** can be formed of a flexible material as in the case of the above-described embodiments. However, in the case where the bumper **3** and the side suction port **34** are connected to each other by the connecting body **62**, the flexibility is unnecessary.

[0081] In the above-described configuration, since the side suction port **34** disposed on the same surface as the side surface of the bumper **3** moves in association with the movement in the right and left direction of the bumper **3**, even if the bumper **3** collides with a wall surface and moves to the inside in the right and left direction, the side suction port **34** follows in association with the movement of the bumper **3** by means of the connecting body **62**. Therefore, the side suction port **34** is prevented from being left alone and damaging the wall surface.

[0082] In the above-described embodiments, an example in which the main suction port, the front suction port, and the side suction ports are provided in the suction port body has been explained. However, the suction port body may be configured so that the front suction port is not formed. Also, in the above-described embodiments, explanation has been given by taking a self-propelled vacuum cleaner as an example. However, the present invention can be applied to a manually-operated vacuum cleaner.

1. A vacuum cleaner in which a suction port body having a suction port is provided on the front side of a cleaner body, and an expanding means for expanding the suction port body toward the side is provided.

2. The vacuum cleaner according to claim 1, wherein the expanding means expands the suction port body toward the side when the side of wall is cleaned.

3. The vacuum cleaner according to claim 1, wherein the suction port body has a rotating brush, and the suction port communicating with a dust collection section is formed on a wall surface of a dust suction chamber of the suction port body accommodating the rotating brush.

4. The vacuum cleaner according to claim 3, wherein the expanding means is configured so that a part of the suction

port body is projected from the cleaner body to expand the dust suction chamber to the side.

5. The vacuum cleaner according to claim 1, wherein a suction port variable means is provided to displace the suction port in a projecting direction in association with an expansion of the suction port body.

6. The vacuum cleaner according to claim 1, wherein an obstacle detector is provided to detect an obstacle located at the side of the cleaner body so that when the vacuum cleaner approaches a wall, the expanding means projects a part of the suction port body from the cleaner body.

7. The vacuum cleaner according to claim 1, wherein an obstacle detector is provided to detect an obstacle located at the front and at the side of the cleaner body so that when the vacuum cleaner approaches a corner of a room, the expanding means projects a part of the suction port body from the cleaner body.

8. The vacuum cleaner according to claim 6, wherein when the vacuum cleaner goes away from the side of wall or when cleaning at the side of wall is finished, the expansion means retracts a part of the suction port body into the cleaner body.

9. The vacuum cleaner according to claim 1, wherein the expanding means is side suction ports provided in both end portions at the right and left of a dust suction chamber of the suction port body so as to extend to the side.

10. The vacuum cleaner according to claim 9, wherein the side suction port is formed of a flexible material.

11. The vacuum cleaner according to claim 9, wherein the side suction port is formed so as to project to the side from the overall width of the cleaner body.

12. The vacuum cleaner according to claim 9, wherein a rotating brush is accommodated in the dust suction chamber so as to be rotatable around a horizontal shaft, and bearing portions at both ends of the rotating brush each are covered by a dust-proof cover to prevent dust and dirt having been sucked through the side suction port from intruding into the bearing portion.

13. The vacuum cleaner according to claim 9, wherein a bumper is provided so as to cover the front and the side of the cleaner body, the bumper being attached to the cleaner body so as to be movable in a front and rear direction and in a right and left direction, and the side suction port provided on a same surface as a side surface of the bumper moves in association with a movement in the right and left direction of the bumper.

14. The vacuum cleaner according to claim 1, wherein the vacuum cleaner has a running means for running the vacuum cleaner on a floor surface and a steering means for controlling the running direction to make it possible for the vacuum cleaner to run automatically.

15. The vacuum cleaner according to claim 7, wherein when the vacuum cleaner goes away from the side of wall or when cleaning at the side of wall is finished, the expansion means retracts a part of the suction port body into the cleaner body.

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